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Physics 30

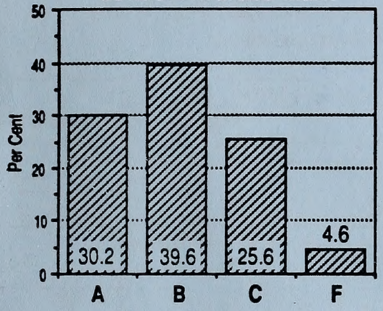
Diploma Examination Results ✓

Examiners' Report

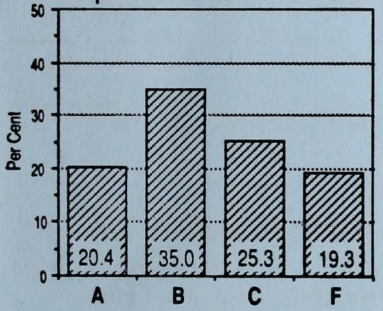
January 1992

CANADIANA
APR - 6 1992

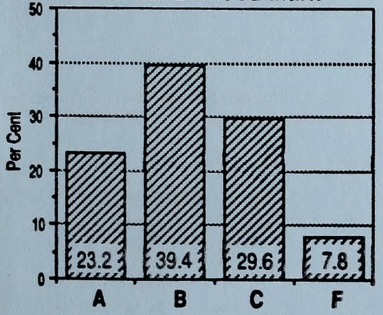
School-Awarded Mark



Diploma Examination Mark



Final Blended Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1992 administration of the Physics 30 Diploma Examination. The information is most helpful when used in conjunction with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results will be available next fall.

Description of the Examination

The Physics 30 Diploma Examination consists of two parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of four questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final blended marks achieved by 3 338 students who wrote the January 1992 examination.

- 92.2% of these students achieved the acceptable standard (a final blended mark of 50% or higher).
- 23.2% of these students achieved the standard of excellence (a final blended mark of 80% or higher).

Overall, student performance in Physics 30 was satisfactory. Students' problem-solving skills continued to improve and they had a good understanding of course content.

Provincial Averages

- The average school-awarded mark was 71.2%.
- The average diploma examination mark was 64.9%.
- The average final blended mark, representing an equal weighting of the school-awarded and diploma examination marks, was 68.4%.

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Results and Examiners' Comments

Subtest

When analysing any detailed examination results, please bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 33.4 out of 48

Written response: 11.3 out of 21

- **Course Content**
  - -Light: 10.0 out of 16
  - -Electric and Magnetic Fields: 12.0 out of 18
  - -Electromagnetic Radiation: 6.8 out of 10
  - -Structure of Matter: 8.8 out of 14
  - -Modern Physical Theories: 7.1 out of 11
- **Process Skills:** 21.0 out of 37
  - -Multiple-choice questions 5, 10, 17, 18, 19, 22, 23, 24, 27, 28, 34, 35, 40; numerical-response questions 3, 4, 6; and written-response questions 1, 2, 3, and 4
- **Cognitive Levels**
  - -Knowledge: 12.0 out of 17
  - -Comprehension and Application: 22.9 out of 34
  - -Higher Mental Activities: 9.7 out of 18

Examination Blueprint

Each question on the examination is classified in two ways: according to the curricular content area being tested and according to the cognitive level demanded by the question. The examination blueprint illustrates the distribution of questions in January 1992 according to these classifications. Numbers with brackets [ ] indicate written-response questions, those with parentheses ( ) indicate numerical-response questions, and those without parentheses or brackets indicate multiple-choice questions.

	Questions by Cognitive Level			
Reporting Category	**Knowledge**	**Comprehension and Application**	**Higher Mental Activities**	**Examination Emphasis (%)**
Light	3, 4, 6, 8	1, 2, 5, 7, (1), (2)	[3]	23
Electric and Magnetic Fields	9, 11, 14, 15, 16	10, 12, 13, 18, 20*, (3), [2]	17, 19, (4)	27
Electromagnetic Radiation	21, 25	22, 23, 26, 27, 29 (5)	24, 28	14
Structure of Matter	30, 32, 33, 36	31, 37, (6) [4]	34,35	20
Modern Physical Theories	38, 42	39, 40, 41, (7)	[1]	16
Examination Emphasis (%)	24	50	26	100

* Note: Question 20 was deleted from the examination; see page 3 for a discussion of this question.

This examination has a balance of question types and difficulties. It is designed so that students capable of achieving the acceptable standard will obtain a mark of 50% or higher and students capable of achieving the standard of excellence will obtain a mark of 80% or higher. For the first time, the examination includes numerical-response questions. On this examination, students handled these questions very well. Students achieving the acceptable standard were expected to show good communication skills in the written-response section of the examination, regardless of whether their responses were in calculation or verbal form.

Multiple Choice

Question	**Key**	**Difficulty***	**Question**	**Key**	**Difficulty***	**Question**	**Key**	**Difficulty***
1	D	91.6	15	B	78.8	29	D	69.7
2	A	52.6	16	C	73.0	30	D	53.7
3	A	47.0	17	D	45.1	31	D	88.9
4	C	73.2	18	B	52.4	32	C	72.3
5	C	57.1	19	A	68.2	33	A	84.2
6	A	67.6	20	question deleted		34	B	71.1
7	D	89.2	21	C	92.5	35	D	49.9
8	B	68.9	22	D	54.6	36	A	73.4
9	C	70.9	23	A	59.1	37	C	64.9
10	D	88.9	24	A	49.3	38	D	46.1
11	D	83.8	25	B	70.9	39	B	86.9
12	C	63.2	26	A	89.9	40	B	81.0
13	C	75.9	27	B	58.9	41	D	78.1
14	A	81.6	28	B	55.7	42	A	64.6

* Difficulty—percentage of students answering the question correctly

Multiple Choice

All students were expected to demonstrate a high level of competence in calculations. Those achieving the standard of excellence were expected to apply knowledge to unusual problems and to use scientific generalizations effectively. Performance on the multiple-choice section of the examination was generally satisfactory. Students found the calculation questions to be the easiest. The multiple-choice average score was 69.6%. Detailed comments on questions 24 and 34 follow.

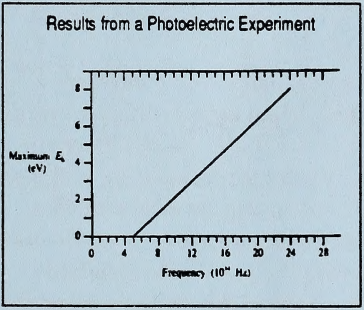
For a complete breakdown of student responses by alternative for the multiple-choice questions, please refer to the school and jurisdiction reports.

24. A garage door opener is designed so that it has an operational distance equal to 55 wavelengths. When the frequency is reduced from 205 MHz to 155 MHz, the increase in operational distance is

● **A.** 26 m
B. 80 m
C. 110 m
D. 330 m

Question 24 asked students to apply their knowledge to a common experience. The operational range for a transmitter of a garage door opener was given in terms of wavelength. Students were expected to find the increase in range that would correspond to a decrease in frequency. Students achieving the standard of excellence had little difficulty with this question. Less than half of those achieving at the acceptable standard but not achieving the standard of excellence answered this question correctly. The most common mistake was calculating one or both of the ranges and failing to find the difference. A small number of students who understood that the difference in the range was required used the difference in the frequencies to calculate the answer.

Use the following diagram to answer question 34.



34. The maximum kinetic energy of the photoelectrons that are emitted by light of wavelength 1.7 x 10^{-7} m is

A. 1.1 eV
● **B.** 5.2 eV
C. 6.2 eV
D. 7.3 eV

In question 34, students were expected to find the frequency of the incident light and to use this frequency to calculate the kinetic energy transferred to an electron. This could have been done by either using the graph to interpolate an energy value on the vertical axis corresponding to *f* or by using the appropriate kinetic energy equation from the data booklet. The second option required the students to determine the threshold frequency from the graph. Almost three-quarters of the students achieving at the acceptable standard answered this question correctly. Students who chose incorrect answers tended to ignore the work function in the conservation of energy equation.

Question 20 was deleted because the diagram was considered to be ambiguous. Since the north-seeking pole of the compass was not explicitly indicated, two answers could be considered correct, depending on a student's definition of the north-seeking pole.

Numerical Response

Question	Answer	Difficulty*
1	25.4	85.2
2	2.78	78.5
3	8.72	45.8
4	2.16	67.1
5	2.19	76.2
6	2.68	70.9
7	4.56	72.5

* Difficulty—percentage of students answering the question correctly

Most students correctly followed the instructions for filling in the answer sheet. Students who did not round their answers as instructed lost marks. This occurred most frequently in question 1, where it appears students truncated an answer of 25.3 from their calculators instead of rounding the value to the correct answer of 25.4.

All seven questions discriminated well between those students who reached an acceptable standard and those who did not. These questions showed that students achieving the acceptable standard can generate correct responses rather than just select one response from the four provided, as in the multiple-choice format.

2. Light of wavelength 5.73×10^{-7} m illuminates a double slit. On a screen 2.00 m away from the slit, an interference pattern is formed with fringes that are 4.12 mm apart. The distance between the slits, expressed in scientific notation, is $b \times 10^{-w}$ m. The value of b is ____. (Round and record your answer to three digits.)

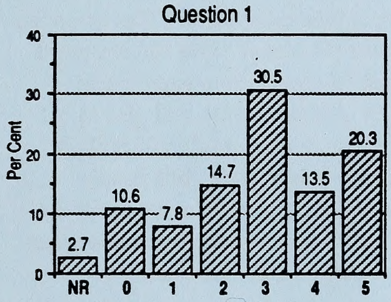
Question 2 was answered correctly by 78.5% of the students. Students were expected to use Young's equation to find the slit separation for a double slit. Students achieving at the acceptable standard were expected to answer this question correctly. Well over half the students achieving just below this standard answered this question successfully. The most common mistake students made was incorrectly substituting 5.73×10^{-7} m for d and solving for λ.

3. Alpha particles, trapped by a magnetic field, are in an orbit of radius 4.36 cm. If the velocity of the particles is exactly doubled, the new radius will be______cm. (Round and record your answer to three digits.)

Question 3 was the most difficult question in the numerical-response section, with 45.8% of the students answering it correctly. Students were expected to equate centripetal force and magnetic force and to realize that R is proportional to v when q, m, and B are unchanged. This question proved challenging for most students. Almost one-third of students achieving the standard of excellence and more than half of those achieving the acceptable standard answered the question incorrectly. 17.5% of the students found that the radius would increase by a factor of four. 10.3% of the students thought the radius would decrease by a factor of two.

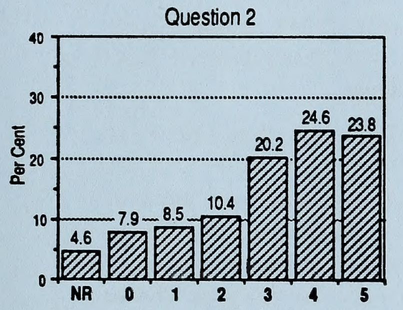
Written Response

The four questions in the written-response section were created from four of the five strands for Physics 30. Students' problem-solving skills were tested most in questions 1 and 2, part c of question 3, and in part b of question 4. Students achieving the acceptable standard on this examination were expected to get 2 out of 5 marks for questions 1 and 4, and 3 out of 5 marks for question 2, and 2 out of 6 marks for question 3. Students performing at the standard of excellence were expected to obtain close to full marks for questions 1 and 2, 4 out of 6 marks for question 3, and 4 out of 5 marks for question 4.



Students did not perform as well as expected on **question 1**. They were required to calculate the relativistic mass for an electron and use this mass to find the electron's kinetic energy and its de Broglie wavelength. Students who achieved the standard of excellence answered the question very well. The lack of structure did not cause much difficulty for this group. Students achieving the acceptable standard but not the standard of excellence were able to calculate the relativistic mass as expected. Many of these students then had difficulty selecting the correct equation for kinetic energy and often used the equation for the energy of a photon to calculate the de Broglie wavelength. A significant number of these students found the kinetic energy or the de Broglie wavelength but not both.

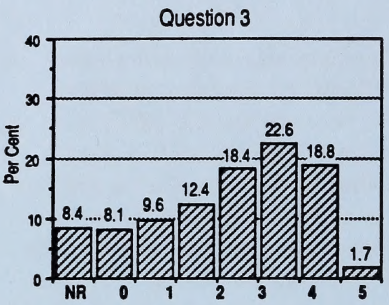
On this 5-mark question, the average score was 2.84 or 57%.



Question 2 was answered quite well. In part a, students achieving the acceptable standard were expected to use the graph to determine the resistance of a wire for two different temperatures. They were then to calculate the decrease in current corresponding to this temperature increase. Students achieving the acceptable standard but not the standard of excellence consistently read the resistance at 24°C to only one decimal place of accuracy, whereas the graph allowed a reading of two decimal places. It seems that these students were unaware that graphs can be read to an accuracy of one-half of the smallest unit. A number of students did not find the change in current even though they successfully calculated the initial current and the final current.

Part b should have been a routine calculation for students achieving the acceptable standard. Students were able to read the necessary values from the graph but consistently had difficulty solving for α and/or using the correct units.

On this 5-mark question the average score was 3.07 or 61%.



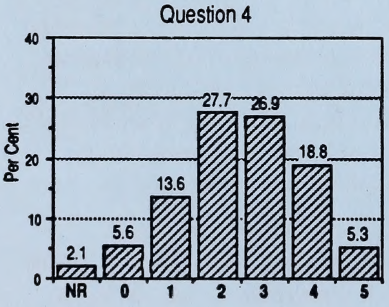
Question 3 proved to be the most challenging for all students. In part a, students were asked to suggest an experimental design that would indirectly measure the width of a double slit. Physics 30 students are generally familiar with Young's experiment and consequently were expected to suggest variations of this experiment as one method. However, many students achieving below the standard of excellence did not specifically state what equipment and measurements were necessary even though they were specifically asked to do so.

Part b was answered fairly well. Most students used an algebraic example rather than a numerical one.

Part c was the most difficult part of this question and was intended to discriminate between those students who achieve the standard of excellence and those who do not. Students were expected to estimate the uncertainties in their measurements and also to explain or determine how these uncertainties would affect their results. Many did not estimate their uncertainties but simply stated where errors in measurement would occur, or students dealt with the effects of *l* or *x* on the slit-separation calculation rather than explaining the effects of the uncertainties in these values.

This question was marked for communication skills. Students achieving the standard of excellence generally showed good communication skills. Their answers demonstrated the clarity and the necessary specificity that was requested. Students achieving below the acceptable standard offered answers that generally required interpretation on the part of the examiner. Their responses were often less specific and less organized than those achieving the standard of excellence.

On this 6-mark question the average score was 2.84 or 47%.



In the first part of **question 4**, the students were asked to calculate the slope of a graph for data from a photoelectric experiment. Students achieving the acceptable standard were expected to receive close to full marks for this part. The most frequent mistakes were in the reading and substitution of data points. A significant number of students did not realize that the horizontal and vertical axes had different scales, and they therefore substituted incorrect values into a slope formula. Many of these students also neglected to include the powers of ten in their slope calculation, or they simply included the correct power of ten in Part b was not answered as well as expected. Students were again

Part b was not answered as well as expected. Students were again given a problem that could have been solved by graphing, but many students attempted to solve it by using a more difficult algebraic method. By extending the graph upwards students could interpolate the value for kinetic energy from the vertical axis corresponding to a given frequency on the horizontal axis. The only calculation necessary was that of the frequency of the incident light. Students achieving the standard of excellence did well using both solutions, with over half getting close to full marks. Those students achieving below this standard tended to use the algebraic solution and had difficulty with one or more parts; many were unable to find the threshold frequency and the work function, or they simply equated the energy of the incident photon to the energy of the ejected electron. A surprising number of students offered solutions using the slope-intercept or point-slope form for the equation of a line without actually using the conservation of energy laws.

On this 5-mark question the average score was 2.51 or 50%.

For further information, contact Craig Emter, Lowell Hackman, or Phill Campbell at the Student Evaluation Branch, 427-2948.